MODULE Q BOOLEAN LOGIC · Q5

Completing a truth table for a logic circuit: mark scheme

21 marks · OCR J277 spec 2.4.1: truth tables; combining Boolean operators using AND, OR and NOT; applying logical operators in truth tables to solve problems; create, complete or edit truth tables for given scenarios; work with more than one gate in a logic diagram

How to use. 1 mark per bullet up to the maximum shown. **/** separates alternative answers. **Truth tables:** output columns are marked in pairs of rows (rows 1–2, 3–4, 5–6, 7–8): 1 mark for each pair where both values are correct. Working columns are not marked unless the question says so. T/F (or True/False) in place of 1/0 is accepted throughout, as the specification allows. Rows are listed in binary order 000 to 111 as printed on the question paper.

<table>
<tr><th>QUESTION</th><th>ANSWER</th><th>MARKS</th><th>GUIDANCE</th></tr>
<tr><td>1(a)
J277 2.4.1</td><td>8</td><td>1</td><td>Accept 2^3 = 8 / eight. Do not accept 9 (heading row counted) or 6.</td></tr>
<tr><td>1(b)
J277 2.4.1</td><td>C (top to bottom): 0, 1, 0, 1, 0, 1, 0, 1</td><td>1</td><td>All 8 values needed for the mark. 1, 0, 1, 0, … does not count up from 000 so = 0.</td></tr>
<tr><td>2(a)
J277 2.4.1</td><td>NOT A and NOT B columns both correct: 1, 1, 0, 0 and 1, 0, 1, 0
(NOT A) OR (NOT B) column: 1, 1, 1, 0
Q column: 0, 0, 0, 1
<table><tr><th>A</th><th>B</th><th>NOT A</th><th>NOT B</th><th>(NOT A) OR (NOT B)</th><th>Q</th></tr><tr><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td></tr></table></td><td>3</td><td>1 mark per bullet. FT: (NOT A) OR (NOT B) correct for the candidate's NOT A and NOT B columns; Q correct as the inverse of the candidate's OR column.</td></tr>
<tr><td>2(b)
J277 2.4.1</td><td>AND (gate) / conjunction</td><td>1</td><td>Accept the AND gate symbol drawn. FT: if the candidate's Q column is 0, 1, 1, 1, accept OR. Do not accept NAND / NOR / XOR (not J277 gates) or "NOT".</td></tr>
</table>

<table>
<tr><th>QUESTION</th><th>ANSWER</th><th>MARKS</th><th>GUIDANCE</th></tr>
<tr><td>3
J277 2.4.1</td><td>P column: 0, 1, 1, 1, 0, 1, 0, 1
1 mark for each correct pair of rows: rows 1–2 (0, 1); rows 3–4 (1, 1); rows 5–6 (0, 1); rows 7–8 (0, 1)
<table><tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>P</th></tr><tr><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td></tr></table></td><td>4</td><td>Max 4. D (= NOT A) and E (= D AND B) are working and are not marked. Common error: leaving out the NOT gate on A (E worked as A AND B) gives P = 0 in row 3 and P = 1 in row 7.</td></tr>
<tr><td>4
J277 2.4.1</td><td>O column: 0, 1, 0, 1, 1, 1, 0, 1
1 mark for each correct pair of rows: rows 1–2 (0, 1); rows 3–4 (0, 1); rows 5–6 (1, 1); rows 7–8 (0, 1)
O = (L AND NOT F) OR M
<table><tr><th>L</th><th>F</th><th>M</th><th>L AND NOT F</th><th>O</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td></tr></table></td><td>4</td><td>Max 4. The working column is not marked; any working headings may be used. Common errors: O = 1 in row 7 (NOT missed on F) or O = 0 in rows 2, 4 or 8 (override ignored).</td></tr>
<tr><td>5
J277 2.4.1</td><td>Row 2 (A=0, B=0, C=1) circled
Row 7 (A=1, B=1, C=0) circled
Row 8 (A=1, B=1, C=1) circled
Correct P column: 0, 1, 0, 1, 0, 1, 0, 0
<table><tr><th>A</th><th>B</th><th>C</th><th>Printed P</th><th>Correct P</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td></tr></table></td><td>3</td><td>1 mark per correct value circled, max 3. Deduct 1 mark for each extra value circled (minimum 0). Accept a row identified another clear way (e.g. ticked, crossed, or the correct value written beside it).</td></tr>
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<tr><th>QUESTION</th><th>ANSWER</th><th>MARKS</th><th>GUIDANCE</th></tr>
<tr><td>6
J277 2.4.1</td><td>P column: 1, 1, 0, 0, 1, 1, 0, 1
1 mark for each correct pair of rows: rows 1–2 (1, 1); rows 3–4 (0, 0); rows 5–6 (1, 1); rows 7–8 (0, 1)
<table><tr><th>A</th><th>B</th><th>C</th><th>A AND C</th><th>NOT B</th><th>P</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td></tr></table></td><td>4</td><td>Max 4. Working columns and their headings are not marked. Common error: row 8 given as 0 (A AND C is 1 even though NOT B is 0).</td></tr>
</table>

Total: 21 marks